BELLCOMM, INC.

SUBJECT: AS 258 Launch Operation Constraints - Case 330

DATE: January 4, 1967

FROM: H. E. Stephens

ABSTRACT

Space vehicles AS 205 and AS 208 are planned as the first Apollo rendezvous mission. The short interval between the two launches and their limited launch windows generate operational problems not heretofore encountered on single Saturn launches. This memorandum identifies and discusses potential problem areas peculiar to AS 258, along with the status of their investigation and/or resolution. A discussion of the Mission Plan, as it determines the launch opportunities, is also included.

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MEMORANDUM FOR FILE

1. INTRODUCTION

Space vehicles AS 205 and AS 208 are planned as the first Apollo rendezvous mission (AS 258). That mission is to (a) demonstrate and verify the functional capability and operability of the Block II CSM and LM and (b) provide flight crew training and development of rendezvous techniques applicable to possible lunar landing mission rendezvous situations. A brief discussion of the Mission Plan, as it affects launch opportunities, is included.

The short scheduled interval between the two launches and the limited launch windows generate operational problems not heretofore encountered on single Saturn launches. A Rendezvous Mission Sub-Working Group has been established under the KSC Apollo Test Integration Working Group to investigate such operational problems. This memorandum identifies and discusses potential AS 258 problem areas being pursued by that Working Group. As noted, solutions have been devised for some with others remaining as continuing action items.

2. MISSION PLAN

a. General

AS 205, to be launched from LC 34, is to insert the CSM into a near-circular 105 nautical mile orbit. AS 208, scheduled to be launched from LC 37 approximately one day later, is to insert the LM into a 110 nautical mile orbit and leading the CSM by 60 nautical miles. The Mission Plan determines the length and spacing of the launch opportunities. More specifically, it determines:

(1) The length and time of day of the AS 205 (CSM) launch window.

(2) The interval between the AS 205 launch and the first AS 208 (LM) launch window.

(3) The length of the AS 208 launch windows, and

(4) The interval between subsequent AS 208 launch windows.

Before identifying the operational constraints imposed by these launch opportunities, the launch window dependence on the Mission Plan is discussed. The sequence of events from AS 205 launch to first rendezvous are included as Appendix A for information. These are based on information provided by the Rendezvous Analysis Branch, Mission Planning and Analysis Division, MSC, to the KSC Rendezvous Sub-Working Group on December 7, 1966.

b. CSM Launch Window

Launch abort recovery, Mission recovery, and lighting conditions for the terminal phase of the first rendezvous establish the AS 205 launch window. These factors establish the launch window as follows:

Beginning of Daily Launch Window

(1) Lighting in the recovery area after a 10 day mission. CSM re-entry to the West Atlantic recovery area is planned after 150 revolutions (~236 hours ground elapsed time (G.E.T.).

End of Daily Launch Window

(1) Lighting in down range abort recovery areas (daylight desired).

(2) Lighting for terminal phase of rendezvous; minimum time of 20 minutes allowed between constant delta height (CDH) and terminal phase intercept (TDI) maneuvers. (See Event #20 in Appendix A.)

AS 258 is presently planned as a summer mission. The above conditions then establish a 1 1/2 hour launch window between 1000 and 1130 EST for AS 205. A delay from the planned launch time of AS 205 will cause a minute-for-minute slip of all AS 208 launch windows.

c. AS 208 Launch Windows

As noted in Events 15, 16, and 19 of Appendix A, the nominal mission calls for insertion of the S-IVB/LM (AS 208) into a 110 nautical mile circular orbit and leading the CSM by

60 miles ($\Delta H \sim 10$ NM). LM insertion is to be followed 9 minutes later by a CSM maneuver ($\Delta V \sim 35$ FPS posigrade) to place it in an equi-period orbit with the LM. One orbit later, the CSM performs a constant delta height (CDH) maneuver to place it in a coelliptic orbit with the LM.

The beginning of the LM launch windows is governed by the geometry which will allow a nominal insertion of the LM 60 nautical miles ahead of the CSM. The KSC CSM orbit nodal crossings will satisfy this condition twice daily--which represent LM launch azimuths of approximately 83 and 96 degrees. The time between these nodal crossings is about 94 minutes. Thus, LM (AS 208) launch windows will occur twice daily, 94 minutes apart. As the LM launch is desired one day after the CSM launch, its first launch window will occur about 23 hours, 27 minutes after the CSM launch. Theoretically, the LM daily launch windows would continue throughout the mission period. In practice, progress of the mission and hardware degradation would have to be evaluated to determine how late in the mission period the LM could be launched.

The other important aspect of the LM launch windows is the length of the individual windows. The beginning of the LM launch window represents the time at which a nominal launch of the LM would insert it 60 nautical miles ahead of the CSM. Any appreciable delay in th LM launch from its planned T-0 will then require phasing orbit(s) to properly position the LM/CSM for the terminal phase intercept maneuver. The question is--how much delay in the LM launch can be tolerated? Seven and one-half to eight hours is currently used for planning as the estimate of the S-IVB orbital lifetime. Rendezvous must be accomplished in this period. In the nominal mission, without phasing orbits, rendezvous would occur about 3 hours after the LM launch. Present planning allows a maximum of 2 phasing orbits. (Note: Three phasing orbits would accomplish rendezvous 7 1/2 hours after launch, or at the end of the S-IVB orbital lifetime). The length of the LM launch window will then be dependent on the catch-up rate of the phasing orbits. Phasing will be accomplished by raising the CSM orbit apogee. Radiation considerations and RCS de-orbit capability limit the phasing orbit apogee to the 100-500 nautical mile range. (Note: As AS 205 is a manned CSM, the phasing orbit apogee will be limited to a height from which de-orbiting can be accomplished by the RCS with one quad out should the SPS fail). The maximum catch-up rate is then about 7 minutes per orbit. With two phasing orbits, the maximum delay of the LM launch that can be accommodated is 14 minutes--or, each of the LM launch windows is of 14 minutes duration.

3. OPERATIONAL CONSIDERATIONS

The planned launches of AS 205 and 208 one day apart then requires dual preparation of the two space vehicles, including overlap in the countdown demonstration tests (CDDT's) and countdowns. The operational procedures and facility loadings must be examined to determine any constraints imposed by the present systems configurations. Some of the areas requiring examination are:

- Flow Chart
- High pressure gases and cryogenics
- Data reduction
- Communications requirements
- Targeting parameter update
- Built-in hold philosophy
- Launch crew availability
- MSC/GSFC interfaces
- Hold/Recycle capability
- C-Band and tracking requirements

These potential problem areas are discussed in more detail in the following paragraphs, including the status of their investigation. This discussion is primarily directed at identification of the potential problem areas and their impact. It can be expected that in most cases the investigation will reveal that constraints do not exist, or that work-arounds can be devised.

4. FLOW CHART

A preliminary AS 258 flow chart has been prepared (dated November 22, 1966) and a copy is included as Appendix B for information. At this time, the flow chart is being reviewed to determine if real constraints exist in such areas as hypergolic loading, overlap of CDDT's and MCC-H interface tests. This flow chart is by no means final, but a concerted effort is being made to produce a realistic flow chart which considers all the practical problems involved. Production of a final flow chart remains a continuing action item.

5. HIGH PRESSURE GASES AND CRYOGENICS

A common convertor compressor facility (CCF) services LC 34 and 37, including high pressure GH_e. In Reference 1, it was stated that the CCF high pressure GH_e system could not

support launches from LC 34 and 37 less than 24 hours apart. That statement was based on predicted usage figures presented to the LC 37B Site Activation Board Meeting on November 4, 1965. Those figures showed that, after a launch, the high pressure GH_e compressors required a 24-hour recovery time to replenish the tanks in an amount sufficient to support the second launch with a back-out capability in the event that it was scrubbed near T-0. At that time, the CDDT's were held several days prior to countdown. The present operational procedure is to go direct from the CDDT's into recycle and countdown, thus placing an added load on the CCF. A current investigation shows that a 5- to 6-day recovery time after the CDDT's would be required by the present CCF equipment before AS 205 could be launched (72-hour recycle to launch after the CDDT is planned). A large portable compressor is expected to be delivered to KSC in March, 1967. Present plans are to permanently install that compressor at the CCF, which will provide the required capacity not only for AS 258, but for other dual launches. Another solution that was investigated by KSC, but ruled out, was to cut down on the usage of GH_e by using GN_2 during the middle portion of the purge. Other gas systems of the CCF are adequate for the dual launch.

The launch vehicle cryogenic supply systems for LC 34 and 37 are independent of each other and do not constrain the vehicle cryogenic loading. Replenish requirements to provide the necessary hold and recycle capability are discussed in paragraph 12.

6. DATA REDUCTION

The following launch support is included in the Central Instrumentation Facility (CIF) function:

a. Preflight data reduction.

b. Preflight simulation and monitoring of telemetry data.

c. Real-time telemetry data monitoring and real-time displays in launch control centers (LCC).

d. Post flight "quick look" data reduction.

e. Off-line computations, tape listings, and assembly of routines.

Support of pre-launch, off-line computations and major tests of the dual preparation represents a potential scheduling constraint. But more important is a possible conflict between (a) AS 205 post flight data reduction required before AS 208 is

launched, and (b) AS 208 terminal countdown. Normally, the detailed requirements would not be available to the CIF until about 90 days before launch. In this case, with the capability to satisfy the requirements considered marginal, the CIF is unable to make a definitive statement of the ability to provide the required support until more information is available. Yet, on the other hand, if requirements that cannot be met with existing configurations are levied 90 days before launch, little time remains to work out a solution or work-around. Consequently, in an attempt to resolve this dilemma and define the problem, an action item was given on December 7 by the Rendezvous Mission Sub-Working Group to MSFC, MSC, and KSC (JA/KA) to have a preliminary statement of their requirements by January 18, 1967. These requirements were requested in sufficient detail to permit an assessment by the CIF. All parties concerned have been cautioned that post flight data reduction prior to AS 208 launch must be held to a minimum.

At this time, the CIF capability to provide the necessary AS 258 launch support must be considered a potential problem area. It is noted that this was also listed in Reference 1 as a potential problem area for closely spaced AAP launches.

7. COMMUNICATIONS REQUIREMENTS

A comprehensive review of the KSC communication equipment (data transmission, voice, video, ETR interface, etc.) has been made by KSC. Based on the present known requirements, it was found that a deficiency of about 50 pieces of terminal equipment existed, along with a shortage of some cabling. KSC is pursuing this problem by:

a. Reviewing requirements for possible deletions.

b. Investigating means of providing added equipment.

It has been stated that an option on an existing contract could be elected to provide the equipment by March, 1967, if proper funds are available.

Communication equipment is a continuing problem area. However, it is being actively pursued and it is expected that it will be resolved.

8. TARGETING PARAMETERS

As noted by Event number 5 of Appendix A, a 10 second SPS confidence burn is planned about 5 hours after CSM insertion.

After the SPS burn, the CSM orbit must be determined, AS 208 targeting parameters updated by MCC-H, assessed by HOSC for performance capability, and the targeting parameters in the AS 208 LVDC updated. The procedure for this update is given by Events 7 through 13 of Appendix A. There are 9 targeting parameters depending on the CSM orbit that will possibly require a LVDC update. These are given in Table I for information.

The present plan calls for MCC-H to transmit the final AS 208 targeting parameter update to the IU LVDC via the DCS in the T-50 to T-40 minute period, with loading via the RCA-110A considered a backup mode. (Final parameter update to have been transmitted to KSC by teletype and verbally verified between T-55 and T-40 minutes.) This procedure has some drawbacks--readout of information entered by the DCS and availability of the RCA-110A for updating.

The best way to read out the new LVDC targeting parameters, if the DCS is used, has not been resolved. Possible ways are a sector dump (10 minutes required) or a special subroutine to read out just the 9 parameters involved. This question is being pursued. Also, it is not likely that the launch would be made if satisfactory readout of the updated parameters could not be accomplished. More information on the command system interface, including system block diagrams, is given in References 2 and 3. The present belief by KSC-JA personnel is that the RCA-110A would not be available to update the parameters as a backup mode at about T-30 minures. That is, at that time the RCA-110A is fully utilized; to enter new cards and interrupt the routine would jeopardize meeting the launch window.

Actually, the RCA-110A is preferred as the prime update mode, with the DCS functioning as a backup. Further investigation is underway by MSC and KSC to determine, (a) if the final data can be made available at about T-90 minutes, and (b) if the RCA-110A can be made available to perform the update at that time. This remains an open action item.

9. BUILT-IN HOLDS

The past KSC/JA philosophy on built-in holds late in the countdown for work catchup was that they would not be used. This procedure was based on proceeding to launch without delay once the vehicle was "brought-up" for launch. The related AS 205 1 1/2-hour and AS 208 14-minute launch windows impose constraints not heretofore encountered in Saturn launches.

TABLE I

AS 208 TARGETING PARAMETERS

R_{igm}	Radius at Insertion, Meters
V_{co}	Inertial Velocity of S-IVB at Cutoff, M/Sec.
V_{igm}	Inertial Velocity Desired at Insertion, M/Sec.
γ_{igm}	Inertial Flight Path Angle Between Velocity Vector and Local Horizontal at Insertion, Deg.
i_{igm}	Instantaneous Inclination of AS 208 Plane Targeted for at Insertion, Deg.
θ_{igm}	Nodal Targeting Parameter, the Angle Between the AS 208 Launch Pad Meridian and the Target Plane Descending Node at the Predicted Time of Guidance Reference Release, Deg.
$\dot{\theta}_{igm}$	Earth-Fixed Regression Rate of the Target Plane (Including Earth's Rotation Rate).
A_Z	AS 208 Flight Azimuth, Clockwise from North, Deg.
t_{grr}	Predicted Time of LV Guidance Reference Release (Approx. 5 Sec. Before Actual Liftoff, HR: MIN:SEC of GMT.

Because of the window constraints, KSC-JA has proposed a 1 to 1 1/2 hour built-in hold in these countdowns to allow for possible work catchup. The hold is proposed for after propellant loading and prior to flight crew ingress for AS 205 and just prior to bringing RF systems up for launch for AS 208 (T-60 to T-30^{m}). The question was previously raised as to why not have a built-in hold just prior to start of the automatic sequence at T-163 seconds. In that case, S-IVB chilldown would limit a planned hold to less than 5 minutes.

Hold capability through the 1 1/2 hour CSM launch window and the 1 1/2 hours between the 2 daily LM launch windows is required. If a 1 1/2 hour built-in hold is added to this, a total of 3 hours hold capability is required for both AS 205 and 208. In an examination of the Apollo/Saturn V Hold and Recycle Capability (Reference 4), it was concluded that CSM/LM constraints from comparable periods in the countdown limited the hold capability to 4 hours. The hold and recycle study work has been refined and extended by KSC-GE to LC 34 (CSM) and LC 37 (LM) (References 5 and 6). Those reports confirmed the 4 hour hold capability. However, later information indicates that this figure may have been optimistic for the CSM fuel cell/cryogenic system.

There does not appear to be any problem in a built-in hold for AS 208. KSC-KA is taking a more detailed look at the CSM to determine if a 1 1/2 hour built-in hold imposes any real constraints.

10. LAUNCH CREW AVAILABILITY

Launch crew availability has long been considered a potential problem for closely spaced launches. This problem is being closely examined, covering the aspects of crew requirements, crew availability, contractural scope, and available resources. Whether launch crew availability will constrain the launch operations is not fully defined and remains a continuing action item.

11. MSC/GSFC INTERFACES

At the present time, the MSC/GSFC interfaces do not appear to offer constraints. These are being further investigated by MSC and GSFC.

12. HOLD & RECYCLE CAPABILITY

Both the need for a built-in hold capability and the present hold capability were discussed in paragraph 9. These are covered in more detail in References 5 and 6. Except for

a re-examination of the CSM fuel cell/cryogenic hold capability, there does not appear to be any serious problem in meeting the hold requirement. It is noted that LH_2 storage tank replenishment will be required for both LC 34 and 37 (References 5 and 6) to satisfy a potential 3 hours total hold time. It is marginal as to whether the LOX storage tanks would require replenishment for these hold times. Both LH_2 and LOX storage tanks would definitely require replenishment for a scrub and recycle.

The problems involved and feasibility of considering a 24 hour hold were not discussed in Reference 5 or 6. CSM fuel cell/cryogenic system constraints preclude such a hold from late in the AS 205 countdown. However, this capability would be of less value for AS 205 than 208. As noted in Reference 5, the AS 208 recycle time required after a scrub late in the countdown is 45.5 hours. Such a scrub would mean a minimum of two days slippage in the LM launch. A 24 hour hold capability from late in the countdown would reduce this by one day. An attempt at such a 24 hold after LV cryogenic loading would introduce new constraints requiring investigation. Some of these questions are:

Can the LV withstand the prolonged cold soak, considering possible system degradation?

Can the LV cryogenic storage tanks be replenished at the sustained rate required for this extended hold?

In Reference 6, the AS 205 CSM recycle time from late in the countdown (after LV cryogenic loading) was given as 50 hours, with no provision for serial repair time. Such a recycle would then involve a launch slippage of three days. As noted in paragraph 2, a slippage in the AS 205 launch causes a day-for-day slip in the AS 208 launch (AS 208 launch countdown underway at scheduled launch time of AS 205). The recycle operations for both AS 205 and 208, but particularly AS 205, should be re-examined for means of shortening. A slight compression of the AS 205 recycle operation would cause only a 2 day slip with some provision for serial repair time. Some of the possible areas for investigation to obtain improvement are:

Lengthening of the LV battery qualified lifetime from 72 hours to delete changing of these batteries.

Possibility of service structure return to the vehicle earlier in the detanking and purging process (safety constraint).

Reduction of S-IVB leak check requirements.

13. C-BAND AND TRACKING REQUIREMENTS

The ETR has advised that there is a possibility that the MILA C-Band TPQ-18 radar will be required elsewhere and may be removed. If so, there will not be C-Band service from MILA for 3 to 8 months. KSC (NC) is working to provide the official KSC position on the C-Band requirement to the ETR. This is a potential problem area of a continuing nature. KSC is also re-evaluating the acceptability of SP 104 van capability for beacon interrogation in lieu of the TPQ-18.

2032-HES-gmp

H. E. Stephens

Attachments
References
Appendix A
Appendix B

Copies to
Messrs. C. H. Bolender - NASA/MO-1
L. E. Day - NASA/MAT
T. A. Keegan - NASA/MA-2
R. O. Middleton - NASA/MO-3
R. V. Murad - NASA/MAT

G. M. Anderson
C. Bidgood
H. F. Connor
D. R. Hagner
J. J. Hibbert
W. C. Hittinger
B. T. Howard
B. Kaskey
J. L. Marshall
J. Z. Menard
I. D. Nehama
T. L. Powers
P. E. Reynolds
I. M. Ross
T. H. Thompson
G. B. Troussoff
R. L. Wagner
Central Files
Department 1023
Department 2032
Library

REFERENCES

1. Discussion of AAP Launch Operations - Case 218, Bellcomm Memorandum of January 19, 1966, by H. E. Stephens.

2. Bellcomm Memorandum for File, "MCC-H/KSC Interface Testing for AS 204 and AS 501 - Case 330," dated 10/13/66, by V. Muller.

3. Bellcomm Memorandum for File, "Abort Advisory System - Case 330," dated 11/30/66, by V. Muller.

4. "Revised Apollo/Saturn V Hold Capability and Recycle Requirements, Case 330," TM 65-2032-4, dated 11/5/65, by C. H. Eley III, V. Muller, and H. E. Stephens.

5. "Space Vehicle Turnaround Complex 37," KSC-GE, dated 11/29/66, by W. A. Thomas, Jr.

6. "Space Vehicle Turnaround Complex 37, KSC-GE, dated 12/6/66, by R. W. Mundy and I. Broome.

APPENDIX A

Event No.	Event	Approx. Ground Elapsed Time (G.E.T.) from AS 205 launch (HR:MIN:SEC.)	Time Until AS 208 Liftoff
1	AS 205 launch. Nominal 1500 GMT liftoff time from LC 34 Launch Azimuth ∿ 83° East of North Inclination will be approximately 28.9°.		
2	S-IVB/CSM insertion into a near circular 105 N. mile orbit.	00:10:05	
3	Crew performs Landmark sightings.	02:00:00	
4	CSM separates from S-IVB over Gulf of Mexico.	03:10:00	
5	CSM performs SPS test burn, ∿ 300 FPS out-of-plane over South Africa.	05:16:00	
6	Begin 16 hour sleep cycle.	05:30:00	
7	MCC-H transmits preliminary 205 CSM ephemeris and AS 208 Targeting parameters for 1st and 2nd launch opportunities to MSFC/HOSC.	06:27:00	17 hrs.
8	HOSC assesses preliminary AS 208 performance capability via computer simulations. Advises MCC-H and KSC of results.	06:27:00 to 21:27:00	17 hrs to 120 min.
9	MCC-H updates AS 208 targeting. Transmits same to HOSC and KSC for go/no-go recommendation.	21:27:00 to 21:57:00	120 min. to 90 min.
10	Possible final targeting update based on US track if meaningful and HOSC is able to accept.	22:07:00	80 min.
11	Final targeting cards punched for RCA-110A load of LVDC in event of DCS problem (backup mode only).	22:07:00	80 min.

Event No.	Event	Approx. Ground Elapsed Time (G.E.T.) from AS 205 launch (HR:MIN:SEC.)	Time Until AS 208 liftoff
12	MCC-H attempts transmission of final 208 targeting via DCS to the LVDC. If three attempts fail, backup load via RCA-110A in LCC is utilized.	22:37:00 to 22:47:00	50 min. to 40 min.
13	Targeting must be loaded.	22:57:00	30 min.
	Computer puts LV on proper launch azimuth. Platform is aligned via RCA-110A, encoder and theodolite.	22:59:00	28 min.
14	AS 208 LM launch from LC 37B $A_Z \approx 83°$.	23:27:00	0
15	S-IVB/LM insertion into 110 N. Mi. circular orbit leading CSM by about 60 N. Mi. $\Delta H \approx 10$ N. Mi. (CSM will have decayed from 105 to 100 mile orbit.)	23:37:00	
16	CSM performs ground commanded phasing maneuver based on actual S-IVB/LM insertion, $\Delta V \approx 35$ FPS posigrade. (If everything is nominal this amounts to placing the CSM in an equi-period orbit with LM, i.e. after one orbit the CSM will still trail the S-IVB/LM by about 55 N. Mi.)	23:45:00	
17	CSM takes sextant sightings of S-IVB/LM to determine the LM orbit.	24:10:00 to 24:45:00	

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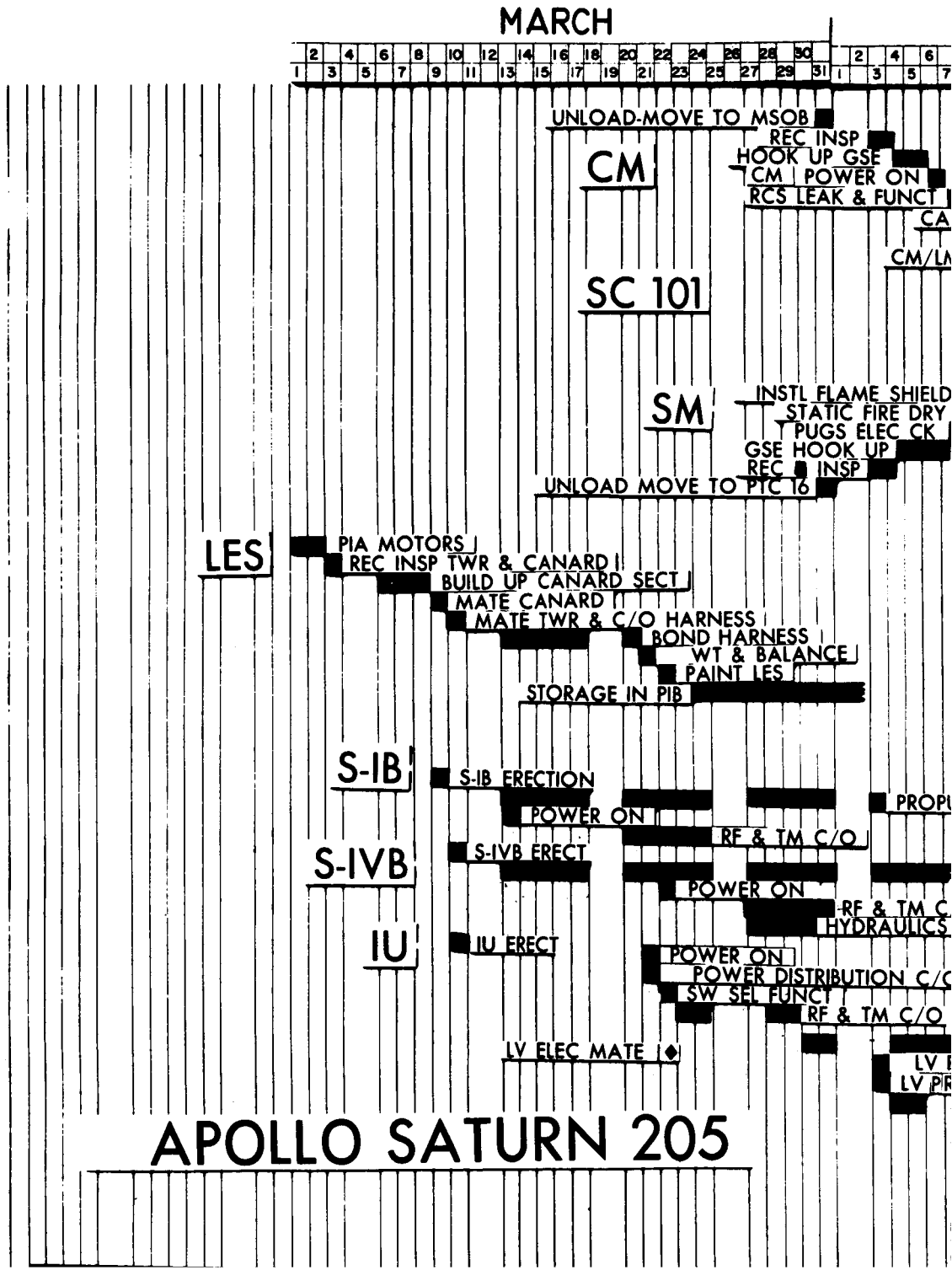
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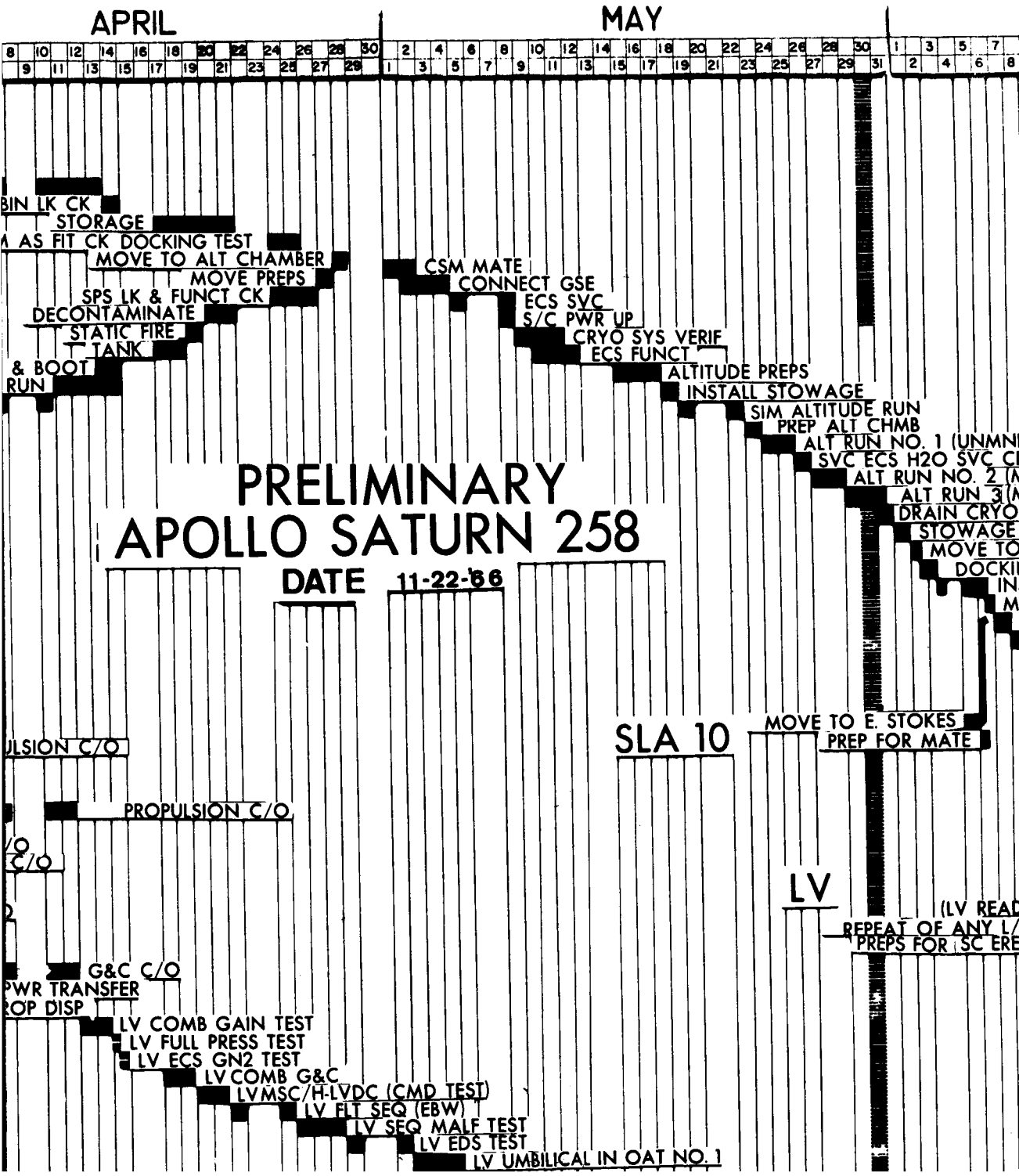
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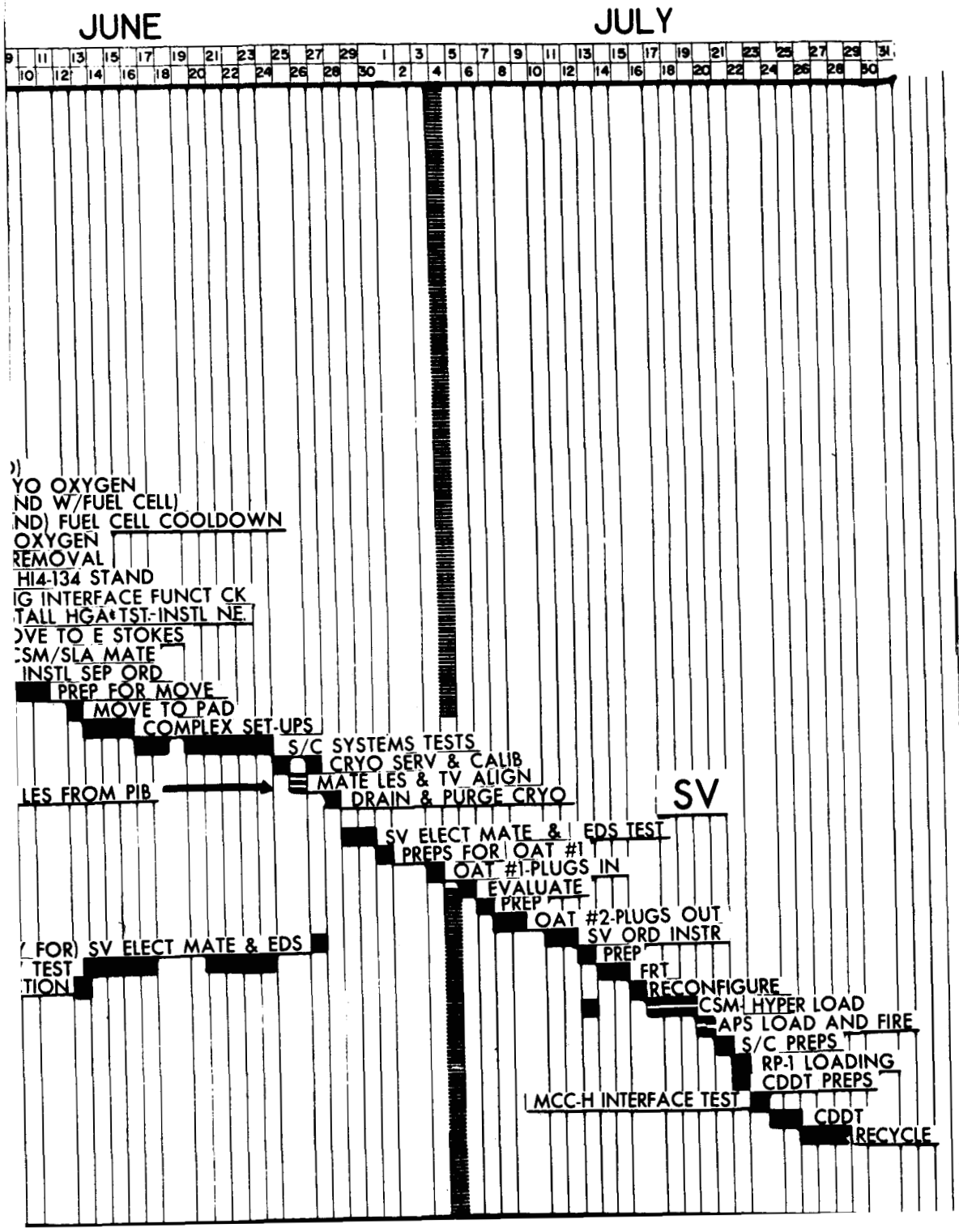
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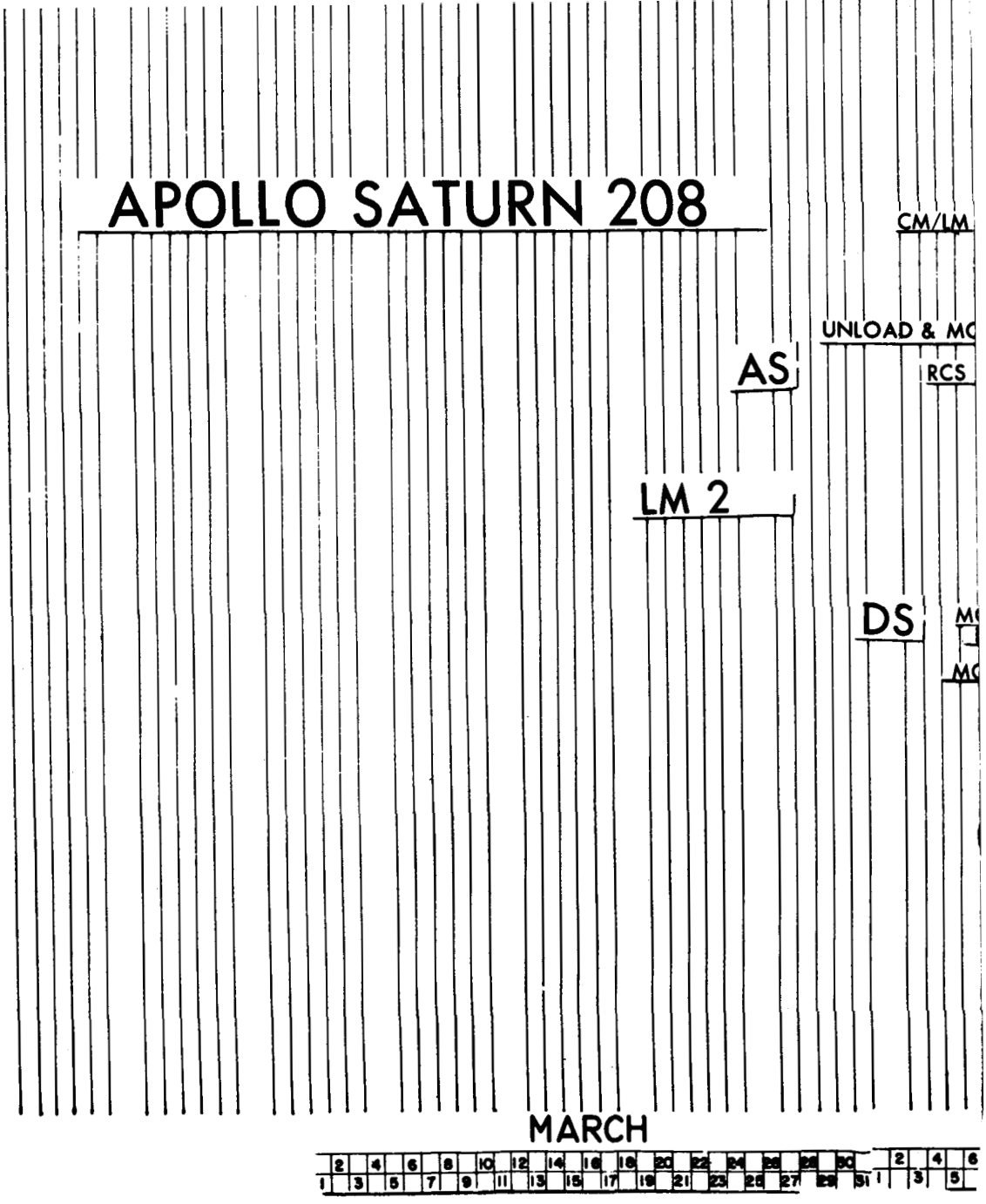
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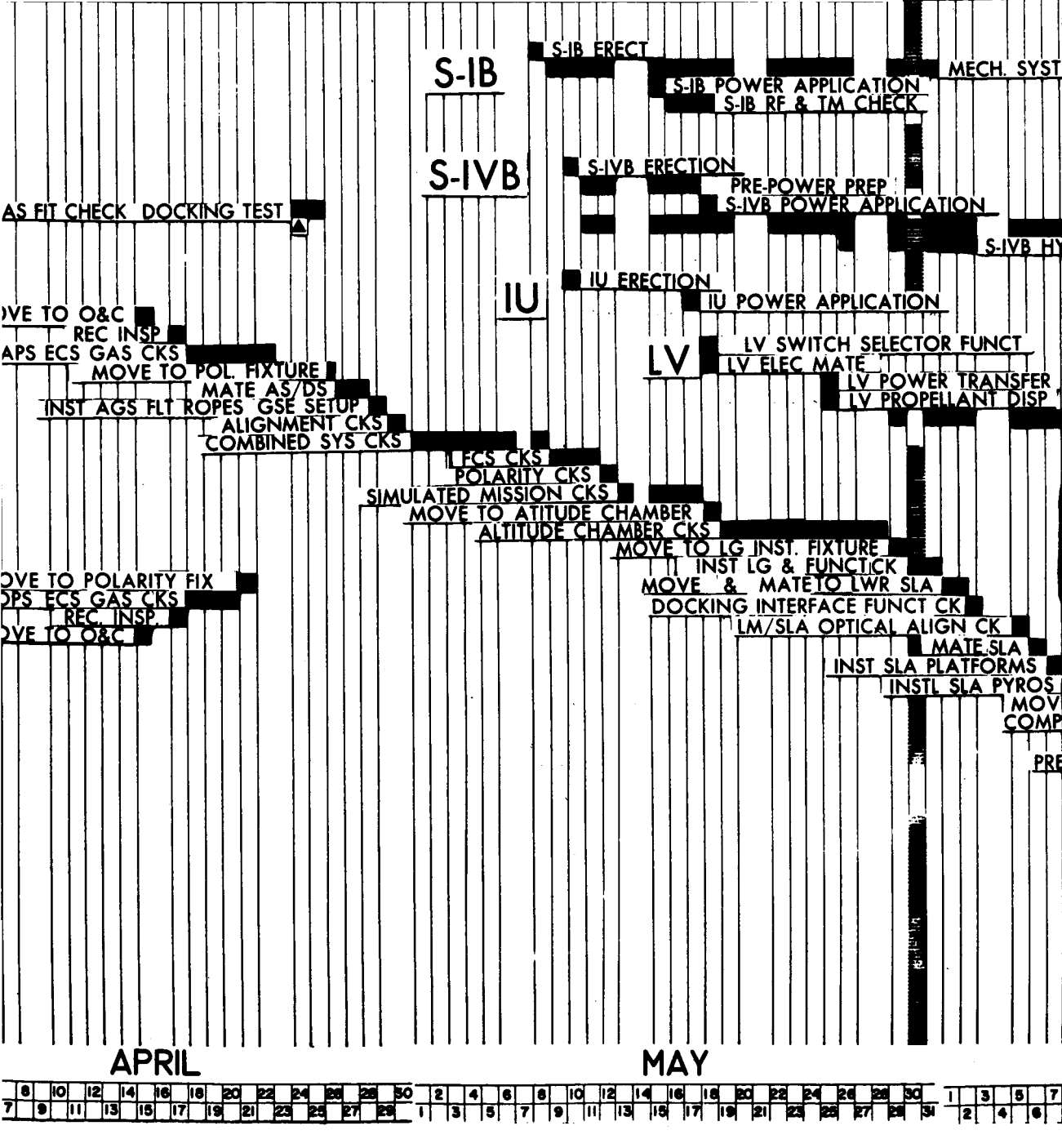
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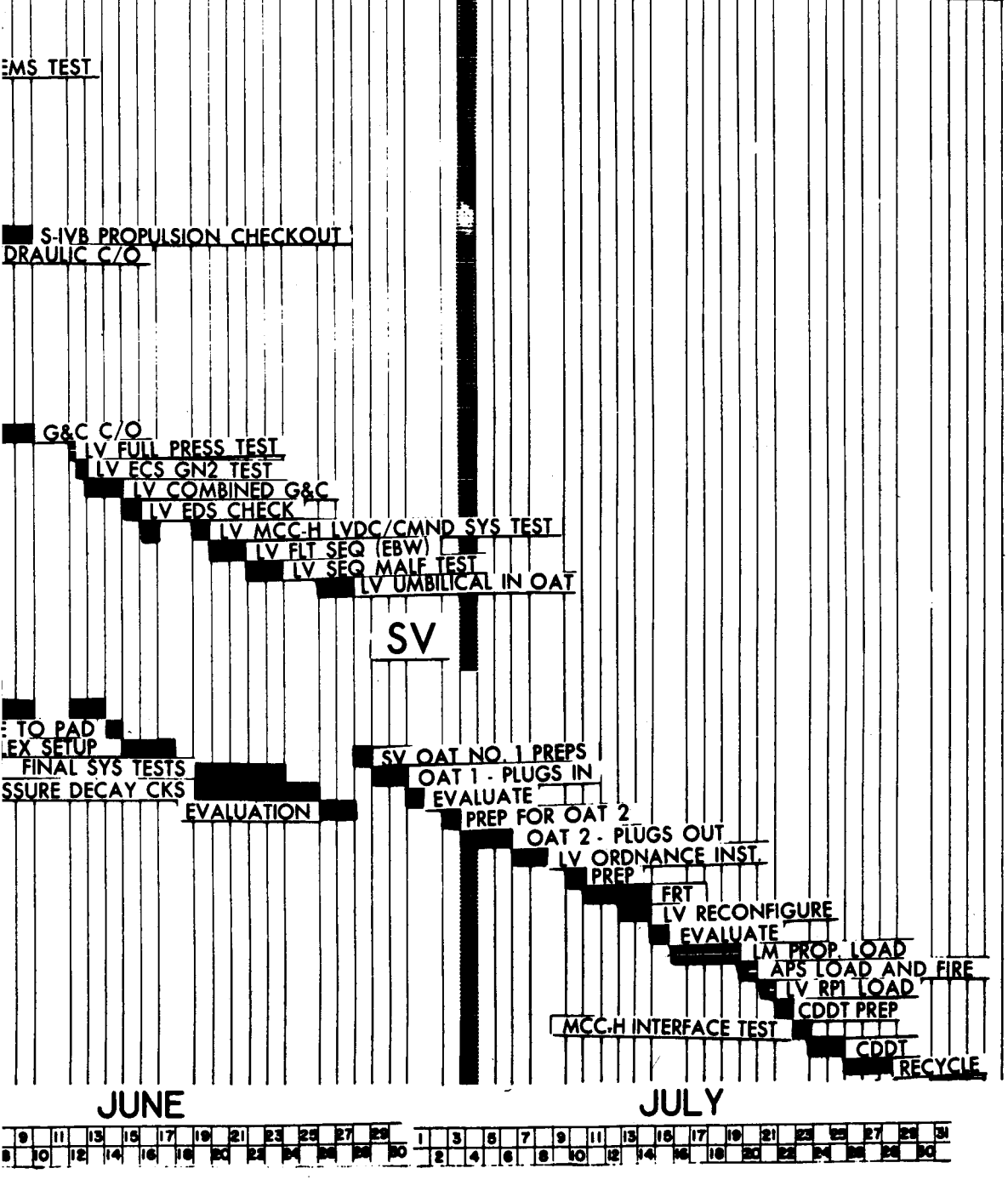
S-IVB ERECTION
PRE-POWER PREP
S-IVB POWER APPLICATION
AS FIT CHECK DOCKING TEST
S-IVB HY
IU
IU ERECTION
IU POWER APPLICATION
VE TO O&C
REC INSP
APS ECS GAS CKS
LV
LV SWITCH SELECTOR FUNCT
LV ELEC MATE
MOVE TO POL. FIXTURE
LV POWER TRANSFER
MATE AS/DS
LV PROPELLANT DISP
INST AGS FLT ROPES GSE SETUP
ALIGNMENT CKS
COMBINED SYS CKS
LFCS CKS
POLARITY CKS
SIMULATED MISSION CKS
MOVE TO ATITUDE CHAMBER
ALTITUDE CHAMBER CKS
MOVE TO LG INST. FIXTURE
INST LG & FUNCTICK
VE TO POLARITY FIX
PS ECS GAS CKS
MOVE & MATETO LWR SLA
REC. INSP.
DOCKING INTERFACE FUNCT CK
VE TO O&C
LM/SLA OPTICAL ALIGN CK
MATE SLA
INST SLA PLATFORMS
INSTL SLA PYROS
MOV
COMP
PRE
APRIL
MAY

B-5


EMS TEST
S-IVB PROPULSION CHECKOUT
DRAULIC C/O
G&C C/O
LV FULL PRESS TEST
LV ECS GN2 TEST
LV COMBINED G&C
LV EDS CHECK
LV MCC-H LVDC/CMND SYS TEST
LV FLT SEQ (EBW)
LV SEQ MALF TEST
LV UMBILICAL IN OAT
SV
E TO PAD
LEX SETUP
FINAL SYS TESTS
SSURE DECAY CKS
EVALUATION
SV OAT NO. 1 PREPS
OAT 1 - PLUGS IN
EVALUATE
PREP FOR OAT 2
OAT 2 - PLUGS OUT
LV ORDNANCE INST.
PREP
FRT
LV RECONFIGURE
EVALUATE
LM PROP. LOAD
APS LOAD AND FIRE
LV RP1 LOAD
CDDT PREP
MCC-H INTERFACE TEST
CDDT
RECYCLE
JUNE
JULY

APPENDIX B-6

Event No.	Event	Approx. Ground Elapsed Time (G.E.T.) from AS 205 launch (HR:MIN:SEC.)
18	CSM performs ground commanded corrective maneuver near Canton. $\Delta V \approx$?	24:45:00
19	CSM performs Constant Delta H (CDH) maneuver to place orbit coelliptic with that of S-IVB/LM, $\Delta V \approx$ 35 FPS.	
20	CSM makes terminal phase intercept maneuver (TPI) to close on S-IVB/LM after 140 degrees of orbit travel, $\Delta V \approx$ 22 FPS (11 Minutes after sunset, look angle to LM 27°.)	25:48:00
21	CSM rendezvous with S-IVB/LM over California	26:30:00
22	CSM hard docks with LM.	27:30:00
23	CSM/LM separation from S-IVB.	28:05:00
24	CSM/LM orbit changed to approximately 110-130 N. Mi.	30:20:00
25	CSM/LM circularizes orbit at 130 N. Mi.	31:05:00
26	Begin 16 hour sleep cycle	